Since January 2020 Elsevier has created a COVID-19 resource centre with free information in English and Mandarin on the novel coronavirus COVID-19. The COVID-19 resource centre is hosted on Elsevier Connect, the company's public news and information website.

COVID-19 Vaccination Patterns and Attitudes Among American Pregnant Individuals

Heather G. HUDDLESTON M.D. , Eleni G. JASWA M.D., M.Sc. , Karla J. LINDQUIST Ph.D. , Amy KAING M.D. , Jerrine R. MORRIS M.D., M.P.H. , Eduardo HARITON M.D., M.B.A. , Jamie CORLEY B.S. , Elena HOSKIN M.P.H. , Stephanie L. GAW M.D. Ph.D. , Marcelle I. CEDARS M.D.

PII: S2589-9333(21)00202-0
DOI: https://doi.org/10.1016/j.ajogmf.2021.100507
Reference: AJOGMF 100507

To appear in: *American Journal of Obstetrics & Gynecology MFM*

Received date: 28 September 2021
Accepted date: 8 October 2021

Please cite this article as: Heather G. HUDDLESTON M.D. , Eleni G. JASWA M.D., M.Sc. , Karla J. LINDQUIST Ph.D. , Amy KAING M.D. , Jerrine R. MORRIS M.D., M.P.H. , Eduardo HARITON M.D., M.B.A. , Jamie CORLEY B.S. , Elena HOSKIN M.P.H. , Stephanie L. GAW M.D. Ph.D. , Marcelle I. CEDARS M.D. , COVID-19 Vaccination Patterns and Attitudes Among American Pregnant Individuals, *American Journal of Obstetrics & Gynecology MFM* (2021), doi: https://doi.org/10.1016/j.ajogmf.2021.100507

Title: COVID-19 Vaccination Patterns and Attitudes Among American Pregnant Individuals

Authors:

Heather G. HUDDLESTON, M.D.* [1], Eleni G. JASWA, M.D., M.Sc.* [1], Karla J. LINDQUIST, Ph.D.[2], Amy KAING, M.D.[1], Jerrine R. MORRIS, M.D., M.P.H.[1], Eduardo HARITON M.D., M.B.A.[1], Jamie CORLEY, B.S.[1], Elena HOSKIN, M.P.H.[1], Stephanie L. GAW, M.D. Ph.D.[1], Marcelle I. CEDARS, M.D. [1]

*These authors contributed equally to the manuscript

Affiliations:

[1]Department of Obstetrics, Gynecology and Reproductive Sciences, University of California San Francisco, CA

[2]Department of Epidemiology and Biostatistics, University of California San Francisco, CA

Conflict of Interest Disclosures:

The authors report no conflict of interest.

Relevant Funding:

The ASPIRE Study was funded by: The Start Small Foundation, California Breast Cancer Research Program (CBCRP), Covid Catalyst Award, Abbvie, Ferring Pharmaceuticals, and individual philanthropists. The funders were not involved in study design; in the collection,

analysis and interpretation of data; in the writing of the report, or in the decision to submit the article for publication.

Trial Registration: NCT04388605

Correspondence to:

Eleni G. Jaswa, M.D., M.Sc.

Assistant Professor

Department of Obstetrics, Gynecology and Reproductive Sciences

Division of Reproductive Endocrinology and Infertility

University of California San Francisco School of Medicine

499 Illinois Street

San Francisco, CA 94158-2519

E-mail: eleni.jaswa@ucsf.edu

Phone: (415) 353-7475

Fax: (415) 353-7744

Word counts: 741 (main text)

Objective

Recent investigations have provided reassuring data on the use of COVID-19 vaccines in pregnant populations (1), and vaccination during pregnancy has now been endorsed by

key organizations, including the American College of Obstetrician Gynecologists (ACOG) and the Society of Maternal Fetal Medicine (SMFM) (2). Yet, the U.S. ranked near the bottom of 16 countries in vaccine acceptance in a recent international survey (3). Granular information regarding predictors of acceptance is lacking. To optimize vaccine acceptance during pregnancy in the United States (U.S.), data on current patterns and attitudes toward vaccination are needed. As of May 2021, just 16% of pregnant persons in a CDC database had received at least one dose of a COVID-19 vaccine (4). In this report, we utilized a nationwide prospective study of pregnant persons, recruited prior to ten weeks gestation, to characterize vaccination rates and acceptance during the first six months of vaccine rollout.

Study Design

Institutional Review Board approval was obtained through the University of California, San Francisco. We analyzed survey data from participants in the Assessing the Safety of Pregnancy in the Coronavirus Pandemic (ASPIRE) study, a nationwide prospective cohort of pregnant individuals recruited early in the first trimester. The study launched in April 2020, with participant recruitment accomplished through social media and web-based communications. Inclusion required pregnancy at less than 10 weeks' gestation and lack of vaccination prior to pregnancy. The current analysis considers respondents who completed at least one vaccine-specific questionnaire between April 1, 2021, and June 30, 2021, with the most recently completed questionnaire utilized. Unvaccinated respondents who indicated a willingness to be vaccinated in the future were defined as having vaccine acceptance. Wilcoxon rank sum or Fisher's exact tests were used to test for bivariable

associations with vaccine status and acceptance. Those significant at the $p<0.1$ level were included in multivariable logistic regression models.

Results

A total of 2,506 community ASPIRE respondents completed at least one vaccine questionnaire, as of June 30, 2021, with 57.4% vaccinated during pregnancy (Table 1). In an adjusted model, predictors of lower odds of vaccination were Black race compared to White race and being counseled not to vaccinate by a provider compared to no counseling. Predictors of higher odds of vaccination were increasing education and income, living in a metropolitan area, and worry over COVID-19. Additionally, being counseled about vaccination, by a provider, was a strong predictor of vaccination compared to receiving no counseling (Figure 1A).

Among the unvaccinated, only 35.7% reported vaccine acceptance. Being advised by a provider not to vaccinate negatively predicted vaccine acceptance. Predictors of higher odds of vaccine acceptance were: some or extreme COVID-19 worry compared to little or none and being counseled about vaccination (Figure 1B). Over time, provider information was a consistent predictor of vaccination and vaccine acceptance (Figure 1C).

Comment

Using data from an on-going, nationwide study launched at the beginning of the COVID-19 pandemic, we found, while a slight majority of pregnant respondents had been vaccinated as of June 2021, there remained substantial vaccine hesitancy with a majority of the

currently unvaccinated individuals indicating no plans to get vaccinated. Race, education, living in a metropolitan area and income were strong predictors of vaccination status, but did not predict vaccine acceptance amongst those currently unvaccinated.

The initial roll-out of COVID-19 vaccine to pregnant persons was complicated by lack of phase three trial data, and there continues to be a need for rigorous investigations on vaccine safety in pregnancy. We found respondents who reported having any vaccine discussion with their provider, even when no advice was given, were more likely to be vaccinated, suggesting providers can play an important role in improving vaccination rates. Public health strategies should prioritize provider and public education regarding adverse effects of COVID-19 in pregnancy and evolving safety data for the vaccine in this group (5). Critically, authorities including the CDC, ACOG and SMFM now recommend vaccination for all pregnant individuals. Encouragingly, we found the decision to vaccinate evolved, with many participants reporting a shift in attitude from no-acceptance to acceptance on the final survey.

Strengths and Limitations

Our sample size is large and distributed across diverse regions and backgrounds, but also represents those who chose to participate in a longitudinal cohort study focused on COVID19. Therefore, as with any observational study, limitations include generalizability to the larger population.

Conclusion

Overall, our data characterize the current landscape of COVID-19 vaccination during pregnancy in the U.S., highlighting opportunities for improving vaccination rates in this high-risk group.

Acknowledgements

The ASPIRE Study was funded by: The Start Small Foundation, California Breast Cancer Research Program (CBCRP), Covid Catalyst Award, Abbvie, Ferring Pharmaceuticals, and individual philanthropists.

References

1. Shimabukuro TT, Kim SY, Myers TR, Moro PL, Oduyebo T, Panagiotakopoulos L, et al. Preliminary Findings of mRNA Covid-19 Vaccine Safety in Pregnant Persons. N Engl J Med. 2021.
2. ACOG and SMFM Recommend COVID-19 Vaccination for Pregnant Individuals 2021 [Available from: https://www.acog.org/news/news-releases/2021/07/acog-smfm-recommend-covid-19-vaccination-for-pregnant-individuals.
3. Skjefte M, Ngirbabul M, Akeju O, Escudero D, Hernandez-Diaz S, Wyszynski DF, et al. COVID-19 vaccine acceptance among pregnant women and mothers of young children: results of a survey in 16 countries. Eur J Epidemiol. 2021;36(2):197-211.
4. Razzaghi H, Meghani M, Pingali C, Crane B, Naleway A, Weintraub E, et al. COVID-19 Vaccination Coverage Among Pregnant Women During Pregnancy - Eight Integrated Health Care Organizations, United States, December 14, 2020-May 8, 2021. MMWR Morb Mortal Wkly Rep. 2021;70(24):895-9.
5. Villar J, Ariff S, Gunier RB, Thiruvengadam R, Rauch S, Kholin A, et al. Maternal and Neonatal Morbidity and Mortality Among Pregnant Women With and Without COVID-19 Infection: The INTERCOVID Multinational Cohort Study. JAMA Pediatr. 2021.

Tables

Table 1. Participant characteristics by vaccination status

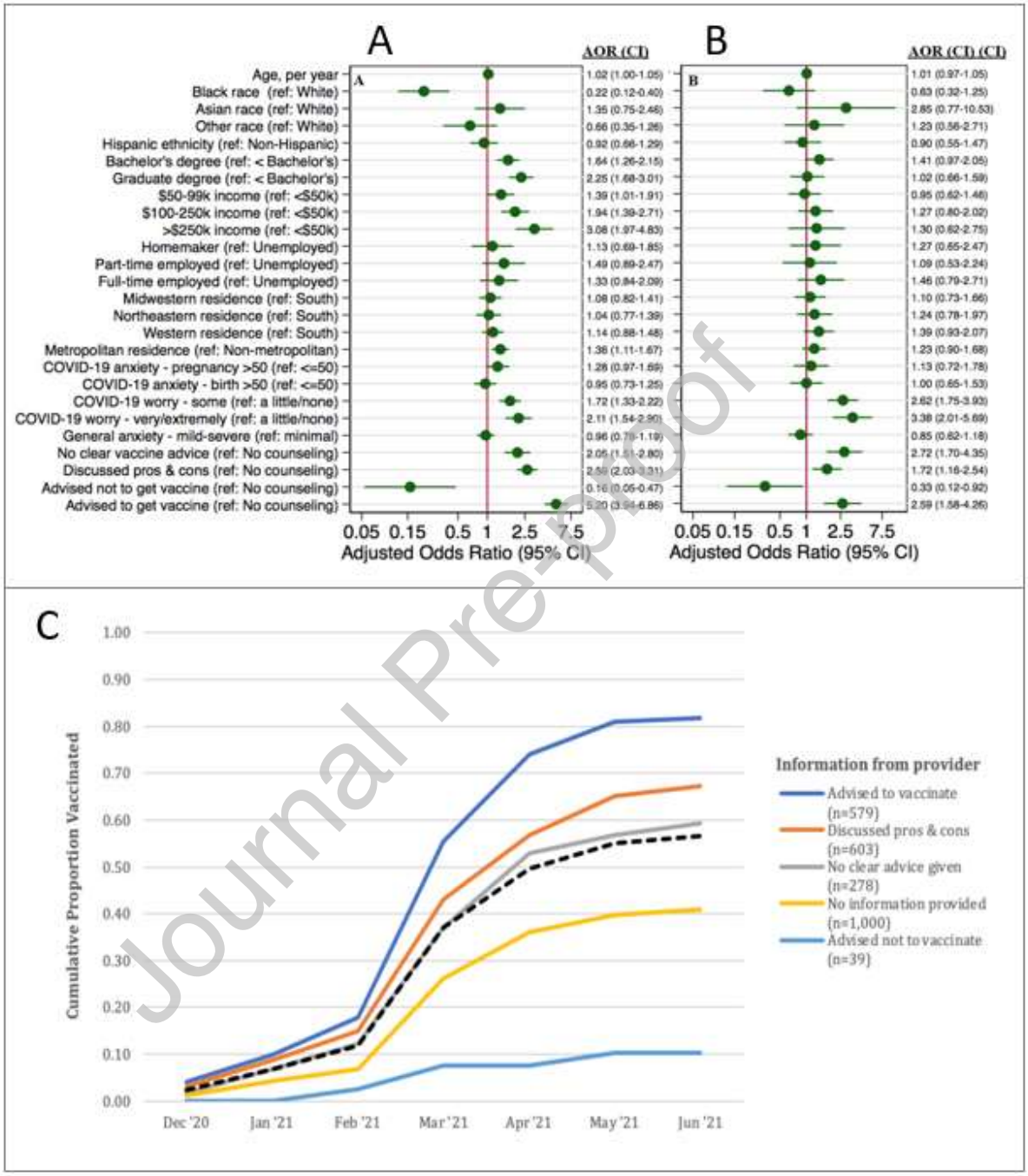
Characteristic or Group	Overall Mean (SD) or N (%) of Cohort	Unvaccinated Mean (SD) or % of Group	Vaccinated Mean (SD) or % of Group	P-value
Age at enrollment (years)	32.3 (3.9)	31.8 (4.5)	32.7 (3.7)	<0.001
Race				
White	2,100 (83.8)	41.8	58.2	<0.001
Black	78 (3.1)	78.2	21.8	
Asian	91 (3.6)	20.9	79.1	
Native American	19 (0.8)	36.8	63.2	
Mixed/Other	127 (5.1)	47.2	52.8	
Ethnicity				
Not Hispanic	2,135 (85.2)	41.9	58.1	0.054
Hispanic	273 (10.9)	48.0	52.0	
Education				
Less than Bachelor's degree	579 (23.1)	66.8	33.2	<0.001
Bachelor's degree	903 (36.0)	42.4	57.6	
Graduate degree	985 (39.3)	29.5	70.5	
Household income				
<$50,000	391 (15.6)	68.5	31.5	<0.001
$50,000-$99,000	730 (29.1)	50.7	49.3	
$100,000-$250,000	1,078 (43.0)	33.6	66.4	
>$250,000	266 (10.6)	22.2	77.8	
Work status				
Unemployed	137 (5.5)	61.3	38.7	<0.001
Full-time homemaker	366 (14.6)	55.5	44.5	
Part-time employment	316 (12.6)	45.6	54.4	
Full-time employment	1,648 (65.8)	38.2	61.8	
Employed in a healthcare field				
No	1,824 (72.8)	42.6	57.4	0.476
Yes	640 (25.5)	44.2	55.8	
Region of residence				
South	718 (28.7)	47.9	52.1	0.011
Midwest	596 (23.8)	43.3	56.7	
West	706 (28.2)	39.9	60.1	
Northeast	405 (16.2)	39.8	60.2	
Lives in a metropolitan area				
No	978 (39.0)	51.4	48.6	<0.001
Yes	1,448 (57.8)	37.4	62.6	

COVID-19 anxiety/worry (baseline)				
Anxiety about pregnancy (1-100)	50.3 (25.8)	44.8 (28.9)	54.3 (24.5)	<0.001
Anxiety about giving birth (1-100)	53.4 (26.0)	50.7 (30.1)	55.4 (25.0)	0.004
Worry about self/loved ones being affected				
A little/not at all	796 (31.8)	56.9	43.1	<0.001
Somew hat	933 (37.2)	37.8	62.2	
Extremely/very	700 (27.9)	32.6	67.4	
General anxiety/worry (baseline)				
GAD-7 score (0-21)	4.5 (4.2)	4.7 (4.6)	4.3 (4.1)	0.246
Minimal (GAD-7 score 0-4)	1,445 (57.7)	40.9	59.1	0.064
Mild-Severe (GAD-7 score 5-21)	941 (37.5)	44.7	55.3	
Provider counseling/advice				
Counseled by provider				
No	1,000 (39.9)	61.5	38.5	<0.001
Yes	1,501 (59.9)	30.6	69.4	
Advice given (if counseled)				
No given clear direction	278 (11.1)	40.3	59.7	<0.001
Discussed pros and cons	603 (24.1)	33.2	66.8	
Told not to vaccinate	39 (1.6)	89.7	10.3	
Told to vaccinate	579 (23.1)	19.3	80.7	
Planning				
Planning to get vaccinated	336 (13.4)	31.2		
Reasons for not planning to get vaccinated	693 (27.7)			
May experience side effects or get sick	195 (7.8)	28.1		
Doesn't think it w ill w ork	80 (3.2)	11.5		
Doesn't need - had COVID-19 infection	94 (3.8)	13.6		
Doesn't need - not at risk	107 (4.3)	15.4		
Doesn't think it's good for them	136 (5.4)	19.6		
Not sure if vaccine is safe in pregnancy	566 (22.6)	81.7		
Allergic to the vaccine/other medical reason	22 (0.9)	3.2		
Other reason*	136 (5.4)	19.6		
Timing				
Gestational w eeks at enrollment	6.9 (1.3)	6.9 (1.3)	6.9 (1.3)	0.312
Gestational w eeks at data collection	19.9 (10.4)	18.2 (12.0)	21.2 (9.5)	<0.001
Weeks betw een data collection and analysis	5.8 (4.1)	4.7 (3.9)	6.5 (4.1)	<0.001
Gestational w eeks at vaccination	16.8 (8.4)		16.8 (8.4)	
Month of vaccination	1,416 (56.5)			
December 2020	59 (2.4)		4.2	
January 2021	115 (4.6)		8.1	
February 2021	123 (4.9)		8.7	

March 2021	630 (25.1)		44.5	
April 2021	316 (12.6)		22.3	
May 2021	140 (5.6)		9.9	
June 2021	35 (1.4)		2.5	

Table 1: SD: Standard deviation; P-values by Wilcoxon rank sum (continuous), or Fisher's exact test (categorical).
Region of residence and zip code variables are based on U.S. Census Bureau data.
GAD-7: general anxiety disorder scale; Minimal: 0-4; Mild-Severe: 5-21
*Of those reporting other reasons, 67.7% also cited at least one of the other listed reasons.

Figure Legends



Titles

Figure 1A (upper left panel). Adjusted odds ratios (95% confidence interval) of vaccination among study population, multivariable model

Figure 1B (upper right panel). Adjusted odds ratios (95% confidence interval) of vaccine acceptance among unvaccinated, multivariable model

Figure 1C (bottom panel). Cumulative proportion of participants vaccinated by information received from provider.

Caption, Figure 1A & 1B

AOR: adjusted odds ratio, CI: confidence interval, Ref: reference

Caption, Figure 1C

Number of participants in each category of information type received from provider are shown in legend on the right.